**Small Business Innovation Research/Small Business Tech Transfer**

# Ultra-Compact, Field-Deployable, Quantum-Compatible Receiver for Free-Space Optical Communication, Phase I

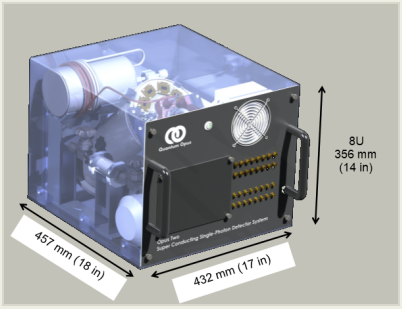
Completed Technology Project (2018 - 2019)

## Project Introduction

Quantum Opus is excited to propose compactifying, enclosing, and automating ALL of the required vacuum, cryogenics, and electrical systems of a superconducting nanowire single-photon detection system into a 14-inch tall by 17-inch wide by 18-inch deep package and re-engineering the optical collection mechanisms to be compatible with existing NASA telescope infrastructure. The end product will be a multi-optical-channel, rack-mountable system roughly the size of an oscilloscope which can, at the push of a button, or remote command, go from a completely dormant to active state. This would include: pumping out its own vacuum can, using active gettering to indefinitely preserve vacuum integrity, activating the integrated helium compressor at appropriate vacuum pressure, and biasing the nanowire detectors at desired base temperature, while enabling continuous counting for near-infrared photons at rates approaching 1 GHz on each optical channel. Wall plug power draw will be ≤300 W and down time for maintenance will only be required every 50,000 hours of run time. The system will host two types of detector payloads, single-mode fiber coupled detectors for integration into terrestrial fiber-optic quantum communications networks and detectors coupled to 50-micron core graded-index multimode fibers for connection to telescopes for either classical or quantum free-space communication. Dark count rates are expected to be between 1 and 10 dark counts Hz per 1550-nm mode for a net dark rate of 1 to 10 kHz for the multimode coupled devices. This will be a transformational technology enabling global-scale deployment of receiver stations for a space-integrated, hybrid classical/quantum, optical communications network for high-rate optical data return from and unassailable secure command and control communications to space telescopes, asteroid mining craft, and other remotely controllable spacecraft.

## Anticipated Benefits

Field deployable receiver for quantum communications, free-space optical communications, and terrestrial fiber-based quantum communications to deliver secure command and control data and high rate science data return for: Mars optical communication receiver (e.g. Deep Space Optical Communications project), Lunar Laser Communications and Laser Communications Relay Demonstration, Agriculture/climate data receiver (e.g., ECOSTRESS), quantum secured optical communications ground station network.




Ultra-Compact, Field-Deployable, Quantum-Compatible Receiver for Free-Space Optical Communication, Phase I

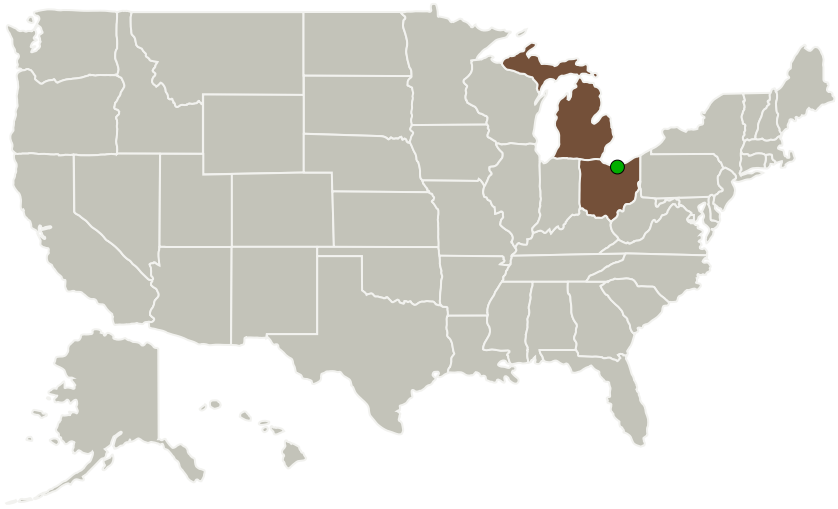
## Table of Contents

# Ultra-Compact, Field-Deployable, Quantum-Compatible Receiver for Free-Space Optical Communication, Phase I

Completed Technology Project (2018 - 2019)

- Commercial quantum and classical optical receivers for satellite downlinks
- Secure communications and high-rate data return for space mining companies
- CASIS-supported optical data downlink partnerships (e.g., Cisco,Syngenta, others)
- Applications requiring large collection areas for diffuse, weak optical sources (e.g., biofluorescence, chemical sensing, optical tomography)

### Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| Quantum Opus, LLC | Lead Organization | Industry | Novi, Michigan |
| Glenn Research Center(GRC) | Supporting Organization | NASA Center | Cleveland, Ohio |

| Primary U.S. Work Locations | |
|---|---|
| Michigan | Ohio |

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

Quantum Opus, LLC

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

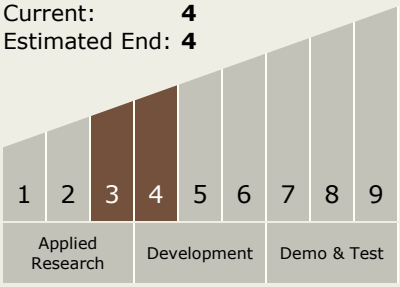
Carlos Torrez

**Principal Investigator:**

Tim Rambo

## Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



# Ultra-Compact, Field-Deployable, Quantum-Compatible Receiver for Free-Space Optical Communication, Phase I

Completed Technology Project (2018 - 2019)

## Project Transitions

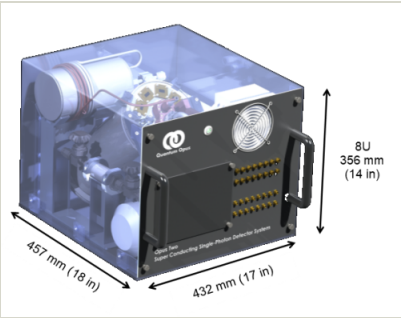
**July 2018:** Project Start

**February 2019:** Closed out

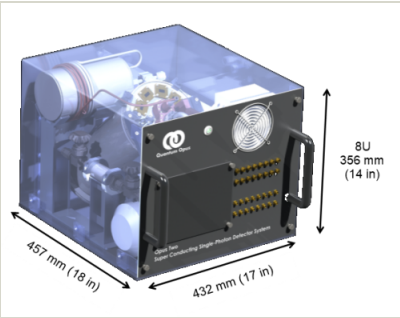
**Closeout Documentation:**

- Final Summary Chart*(https://techport.nasa.gov/file/139401)*

## Images




**Final Summary Chart Image**
Ultra-Compact, Field-Deployable, Quantum-Compatible Receiver for Free-Space Optical Communication, Phase I
*(https://techport.nasa.gov/image/126341)*




**Project Image**
Ultra-Compact, Field-Deployable, Quantum-Compatible Receiver for Free-Space Optical Communication, Phase I
*(https://techport.nasa.gov/image/126265)*

## Technology Areas

**Primary:**

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.5 Revolutionary Communications Technologies
    - TX05.5.2 Quantum Communications

## Target Destinations

Earth, The Moon, Mars